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Faculty Working Papers

INTEGRATING THE WORKING CAPITAL AND

CAPITAL INVESTMENT PROCESSES

James A. Gentry

#179

College of Commerce and Business Administration
University of Illinois at Urbana-Champaign

FACULTY WORKING PAPERS

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May 7, 1974

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James A. Gentry

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ABSTRACT

The objective of this article is to integrate the working capital (WC) and capital investment (CI) processes through the uses of simulation techniques. The variables in the WC and CI modules are presented and the operation of the model explained. Uncertainty related to cash flows is introduced by allowing forecasted sales to vary randomly from actual sales. Separating the costs and benefits of the WC and the CI system provides additional flexibility to decision makers for analyzing the total cash flow of investment alternatives. Testing the sensitivity of each WC variable on the profitability profiles of an investment also provides a new analytical dimension for decision makers. The model highlights the complexity of the total investment planning process and suggests a framework for linking the short-run investment and financing process to the long-run investment system.

INTEGRATING THE WORKING CAPITAL AND CAPITAL INVESTMENT PROCESSES

Capital investment creates the need for additional investment in inventory, accounts receivable and cash throughout the life of the plant and equipment. The investment in working capital also causes a need for an expansion in current liabilities. The theoretical models for selecting capital investment alternatives implicitly assume the costs and benefits of changes in working capital are imbedded in the cash flow of the investment, e.g., Hertz[11, 12], Hespos and Strassman[13], and Weingartner[36].

The following observations highlight the importance of identifying the costs and benefits of working capital as a separate component and linking working capital management explicitly into the total investment planning process. In the early life of an investment more than likely it is operating below capacity, while later in the life cycle there is often an increase in its operating capacity. Thus, throughout the life of an investment there is a continuing buildup in additional investment in working capital. Also the type of investment and the length of the planning horizon will affect the need for additional investment in working capital. Finally, within a corporation working capital management and capital investment planning are separate systems that generally are not linked together for financial planning purposes. These observations indicate the need for a planning model that integrates the working capital processes into the capital investment decision making processes.

The objective of this article is to develop a planning model that simulates the linkage between a corporation's financial operating system and its strategic investment system. For decision makers this model should provide additional analytical insight for evaluating capital investment alternatives.

There have been many valuable theoretical and operational contributions in cash management [1, 2, 4, 18, 24, 25, 26, 32, 38] and in managing accounts receivable and credit selection [3, 4, 5, 17, 19, 20, 21, 37, 39]. At least three sets of authors have linked trade credit policy and inventory management [10, 22, 28] . Linear programming (LP) models were used to introduce the dynamic features of the working capital process. Two large scale LP models were designed (1) to link the sources of short term credit to short term uses [27] and (2) to integrate the variables involved in managing short term cash flow [25] . Walker [35, Chapters 7, 8] and Van Horne 34, Chapter 16 developed general working capital models. Several observations emerge from the preceeding set of articles. Each focused on specific segments of working capital management and each developed sets of relationships among the WC variables. Many of the models did not incorporate the dynamics of uncertainty involved in the short-run investment and financing processes and none of these models were integrated into the capital investment and long-run financing processes of the firm.

The need for integrating the working capital processes into the long-run financial planning processes has been recognized by several authors. A variety of theoretical linkages have been suggested [6, 7, 9, 14, 15, 16, 23, 29, 30 33, 40] . The objective of this article is to offer an

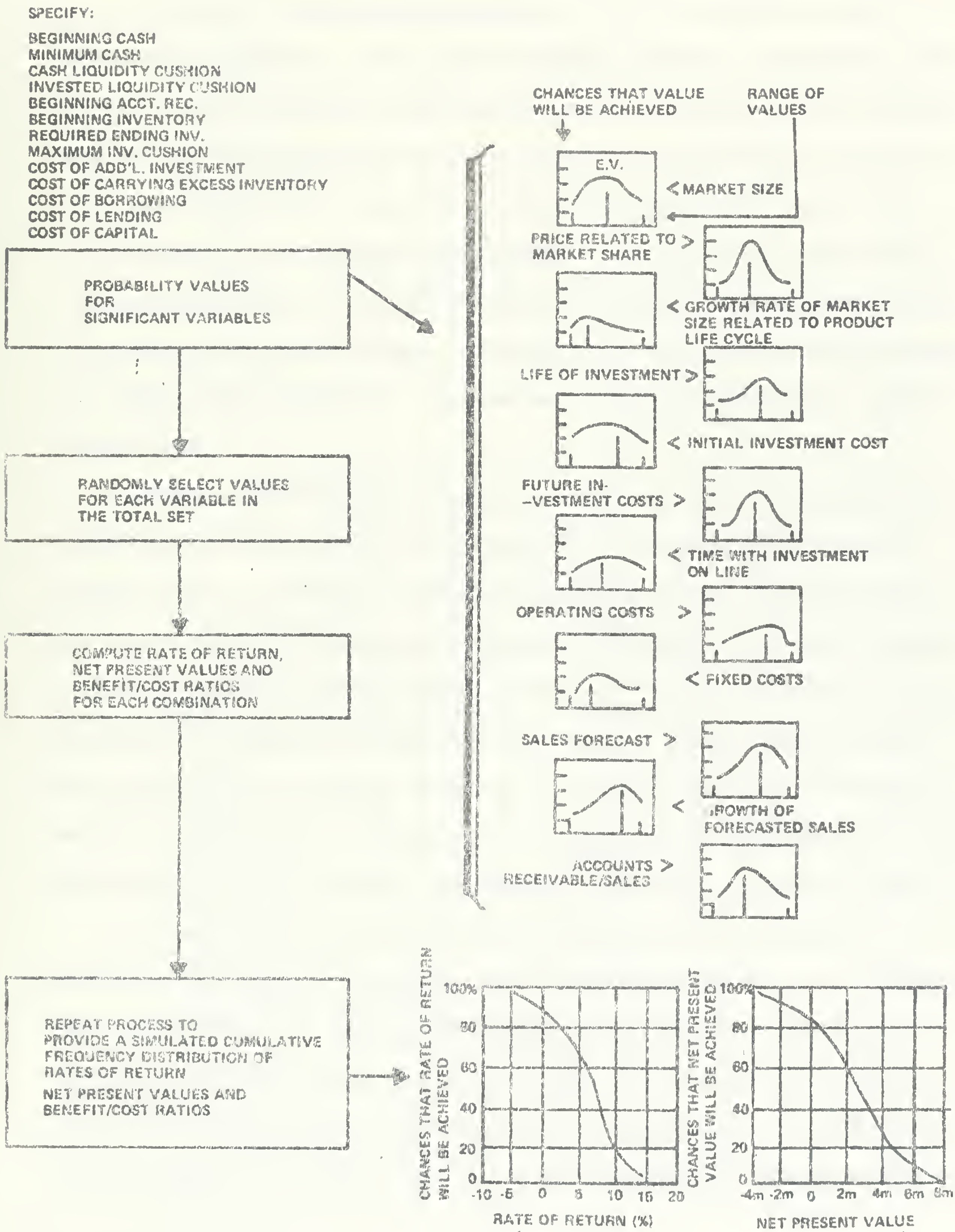
integrated model designed for management decision making and to provide management a model for testing "what if" policy questions concerning the impact of working capital variables on the total profitability of a capital investment alternative.

The model is divided into two parts. The capital investment (CI) module will be presented first followed by the working capital (WC) module.

CAPITAL INVESTMENT MODULE

The financial planning process is composed of many variables and occurs in an uncertain and dynamic environment, therefore, this model will use simulation techniques to represent the interactions among the capital investment and working capital variables. A revised version of the Hertz model [11, 12] is used to simulate the capital investment process. The variables are divided into three major categories--market, investment and cost. The market analysis variables are market size, growth rate of market size related to the life cycle of the product, and market share related to the price of the product. The investment analysis variables are life of the investment, on line time, initial investment cost excluding working capital costs and future investment costs excluding working capital costs. The cost analysis variables are the variable and fixed costs. Each variable is assumed to be stochastic and independent. However, it is assumed the parameters specified for each variable by the decision makers reflects their perception of the interrelationships among the variables. If there are established and clearly identified relationships among variables, these functional relationships can be easily inserted into the model. The variables involved in the capital investment module are presented in Exhibit 1.

EXHIBIT 1
SIMULATION OF THE CASH BUDGETING
CAPITAL INVESTMENT PROCESS

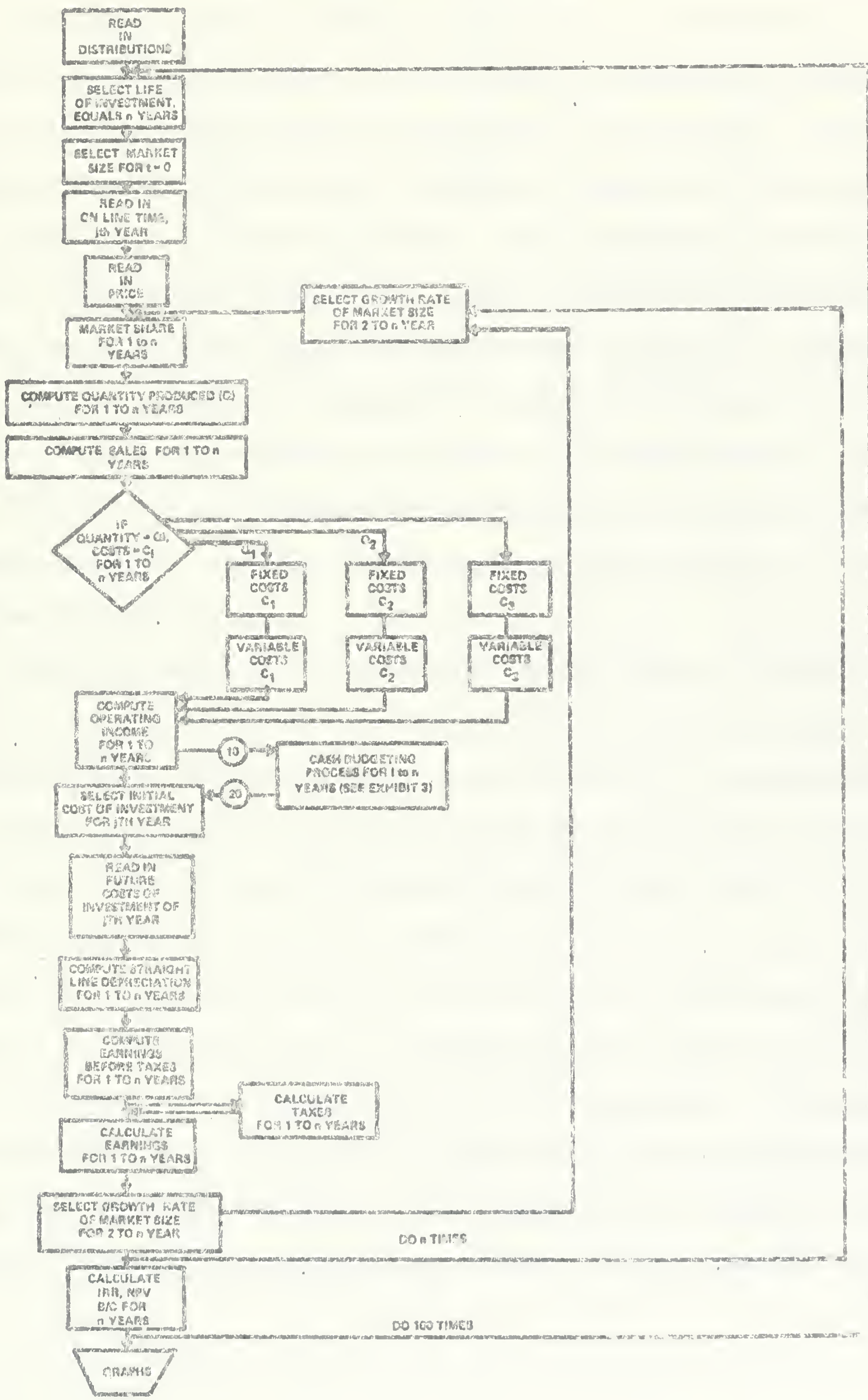


A box chart reflecting the operation of the CI simulation module is presented in Exhibit 2. The program randomly selects in a sequential order a value from the specified distribution for each variable. The uncertain and dynamic characteristics of the CI process are reflected in this random interaction of the variables. The selected values are used in the calculation of a net present value (NPV), internal rate of return (IRR), and a benefit/cost ratio (B/C) for each simulation. This process including the working capital module is repeated 100 times and the final outcomes are profitability profiles or cumulative frequency distributions of NPV, IRR and B/C.

Exhibit 1 depicts profiles of NPV, and IRR. A brief explanation illustrates the interpretation of the profiles. For example, the rate of return profile in Exhibit 1 indicates 80 percent of the time the investment would earn approximately 2.5 percent, 60 percent of the time it would earn approximately 6 percent and 20 percent of the time 10 percent. Thus management can compare the profitability profiles of the several investment alternatives. Another virtue of CI simulation modeling is decision makers can revise their estimates for key variables and determine if NPV, IRR and B/C profiles changed significantly as a result of the new inputs.

An example of two years of output generated by the CI module are presented in Exhibit 3. Comments concerning the operations of the module are also included. A normal distribution was assumed for each of the variables. A price of $12.50 for the product was determined by management and it is assumed the investment came on line in year 1. The range of the market size in year 1 was 2.0 to 2.8 million units and the value

EXHIBIT 2
BOX CHART OF THE CAPITAL INVESTMENT PROCESS



of 2.533 million units was randomly selected from the distribution. The range of the market share was 10 to 18 percent as determined by management and in year 1 the randomly selected value was 12 percent. The quantity produced and the sales were calculated. Variable and fixed costs are dependent on the quantity produced. Thus the variable cost of $6.40 per unit was selected randomly from a range of $5.80 and $6.40 and the fixed cost of $304,000 was selected from a range of $190,000 to $310,000. The operating income was calculated and the initial investment of $10 million was randomly selected from a range of $9 to $12 million. Straight line depreciation was calculated and the remainder of the income statement items determined. The cash flow in year 1 was $1.33 million, i.e., net income plus depreciation.

After the operations of the working capital module are complete in year 1, the program returns to the beginning for year 2 and randomly selects a growth rate in the market size of 8 percent. The growth rate in market size reflects management's perception of the market life cycle and the distributions can vary for each year. A market share of 15 percent was randomly chosen and the program followed the same process presented in year 1. This process continues for year 2 and for the remaider of the life of the investment which is a randomly selected value of ten years. IRR, NPV and B/C are calculated for this first simulation. The program runs 100 simulations and presents a profile of the three profitability measures. The shape and level of these profiles are of substantial importance to management in analyzing the outcomes resulting from their imputs.

EXHIBIT 3

AN EXAMPLE OF OUTPUT GENERATED BY THE CAPITAL BUDGETING MODULE

(000 Omitted)

VARIABLES IN THE CAPITAL BUDGETING MODULE	YEAR 1	YEAR 2	COMMENTS
Price (P)	12.50	12.50	Input
MARKET SIZE (MSIZE)	2533.	2736.	$\widetilde{MSIZE}$ random in year 1; $MSIZE_{t-1}$ $(1 + \widetilde{GMSIZE}_t)$ for year 2; $\widetilde{GMSIZE}$ for t = 2 is .08
Market Share ($\widetilde{MSHR}$)	.12	.15	Random
Quantity (Q)	304.	410.	$MISIZE_t$ $(\widetilde{MSHR}_t)$
Sales (S)	3800.	5125.	$P_t \times Q_t$
Variable Cost (VC)	1946.	2460.	$\widetilde{VC}$ Per Unit x Q; $\widetilde{VC}_1$ per Unit = \$6.40; $\widetilde{VC}_2$ per Unit = \$5.854
Fixed Cost (FC)	304.	265.	$\widetilde{FC}$ related to Q
Operating Income (OI)	1550.	2400	$S_t - VC_t - FC_t$
Investment (BV)	10,000.	9000.	$\widetilde{BV}$ random in year 1; $BV_{t-1} - Depr_t$
Depreciation (Depr)	1000.	1000.	Straight line for 10 years
Earnings before Taxes (EBT)	550.	1400	$OI_t - Depr_t$
Taxes (T)	220.	560.	Tax rate is .4
Net Income (NI)	330.	840.	$EBT_t - T_t$
Cash Flow (CF)	1330.	1890.	$NI_t + Depr_t$

WORKING CAPITAL MODULE

In this module the working capital (WC) process is integrated into the capital investment module. The objectives of linking the short-term operational process to the long-run investment process are (1) to isolate the costs and benefits related to the investment in working capital and (2) to add these costs and benefits attributable to the working capital investment to the costs and benefits related to the plant and equipment investment. The separation of these two systems will provide substantive insight for top management.

Historically the cash budgeting/WC planning process is for a relatively short time period and is revised frequently. Also the WC process is usually independent of the CI planning process. The management of short-run cash flow is a continuous dynamic process occurring in an uncertain environment, but financial literature has generally assumed working capital flows to be short-run, static and deterministic. In this model the WC process is assumed to be a long-run dynamic and probabilistic process. Because the CI model operates on an annual basis it was assumed for convenience sake that the cash budget cycle also operated on a one year horizon. This assumption was made to simplify the calculations of monthly cash budgets and hold down the size of an already complex computer program. The annual cash budget follows the same format as the monthly cash budget, therefore, decision makers can analyze the cash flow operation. Clearly a shorter time period could be programmed to accommodate the needs of decision makers.

<u>Actual Versus Forecasted Cash Flow</u>

The crux of the financial mobility problem occurs when unexpected events occur, e.g., short-run expenditures being greater than forecasted or short-run

cash inflows being less than forecasted, [7, Chapters 3, 7]. Surprise outflows can be related to a sudden need for inventory because actual sales were markedly greater than forecasted. Alternatively, an unexpected decline in inflows arises when actual sales are less than forecasted or if there is a decrease in the inflow from accounts receivables. In both of these cases total cash expenditures are frequently greater than the sum of total cash inflows plus existing cash items.

In simulating conditions for both sales and forecasted sales flows, it is assumed the sales generated in the CI program are the actual sales results and a separate sales forecast is generated by the WC module. Simulating sales conditions where the actual sales are randomly different from forecasted sales captures the essence of the WC management problem.

In the WC module three new probabilistic variables are introduced. These three variables inject the uncertainty prevalent in the WC system into the total financial planning process. The three probabilistic variables are sales forecast $(\tilde{SF})$ in year 1, an annual growth rate of forecasted sales $(\tilde{G})$ related to the life cycle of the product, and an accounts receivable/sales $(\tilde{AR})$ ratio that is related to the quantity of production. These variables are presented in Exhibit 1.

The working capital module is divided into two parts: a production-inventory system and (2) a cash-accounts receivable system. The variables involved in each system are presented and followed by an explanation of the operation of the module.

Production-Inventory System

This segment of the model focuses on the production-inventory process. Management has at its discretion a set of variables that may be used for controlling inventory limits. For the WC module management establishes single point estimates for each of the following production-inventory decision variables. (1) An estimate of the beginning inventory value (BI); (2) A required ending inventory (REI) value which is an estimate of management's desired ratio of ending inventory/sales forecast. REI is related to each level of production. (3) A maximum inventory cushion (MIC) that is expressed as a percent above the required ending inventory ($\overline{REI}$). (4) The cost of additional investment (CAI) is a premium paid for producing additional goods when $S > SF$. CAI is expressed as a percent. (5) The cost of carrying excess inventory (CCI) is a cost that arises when $SF > S$ thereby causing a cash cost for carrying inventory in excess of the forecasted inventory needs. CCI is expressed as a percent and is multiplied times excess inventory to determine the cost of excess inventory.

Cash-Accounts Receivable System

The primary decision variables available to management in controlling levels of cash and accounts receivable are: (1) An estimate of beginning cash value (BC) and beginning accounts receivable (AR); (2) A minimum cash balance ratio (CMIN), cash/sales forecast, expressed as a percent for each level of production; (3) A cash liquidity cushion ratio (CLC) is expressed as a percent above minimum cash balances and CLC is a discretionary variable that can range from zero to a large whole number; (4) An invested liquidity cushion ratio (ILC) is created for investment in short term risk free securities and the ILC is a percent above the cash liquidity cushion. In the

WC module ILC is a positive number because repayment of short term debt comes from the sale of invested securities. Three interest rate variables are: (5) Interest rate on short term borrowed funds (i_b); (6) Interest rate on lending (i_1); (7) Cost of capital (k). The cost of capital is used in the CI module as the discount rate and in the WC module as the rate of return earned on reinvested cash balances that were in excess of the invested liquidity cushion.

OPERATION OF THE WC MODULE

A flow chart of the WC module is presented in Exhibit 4 and a numerical example plus comments concerning the operation of the module are found in Exhibit 5. The example of the WC system in Exhibit 5 is directly related to the CI example in Exhibit 3. Each processing function in Exhibit 4 is numbered. The explanation of each operation of the WC module in Exhibit 5 refers to the appropriate number of the processing function in Exhibit 4. The explanation of the operation of the WC module will follow the example in Exhibit 5.

Production Inventory System

The first step in the WC module is the production-inventory system. All distributions are assumed to be normal in this example of the WC module. The SF_1 of \$4 million in Exhibit 5 was randomly drawn from a distribution with a range between \$3.5 and \$4.4 million. The minimum required ending inventory ($\overline{REI}$) is dependent on the sales forecast. Management determines the REI ratio that is necessary to support the SF. REI_1 is 10 percent and the minimum required ending inventory ($\overline{REI}$) is \$400,000 (.10 x \$4 million). The beginning inventory is zero.

EXHIBIT 4

FLOW CHART OF THE CASH BUDGETING PROCESS

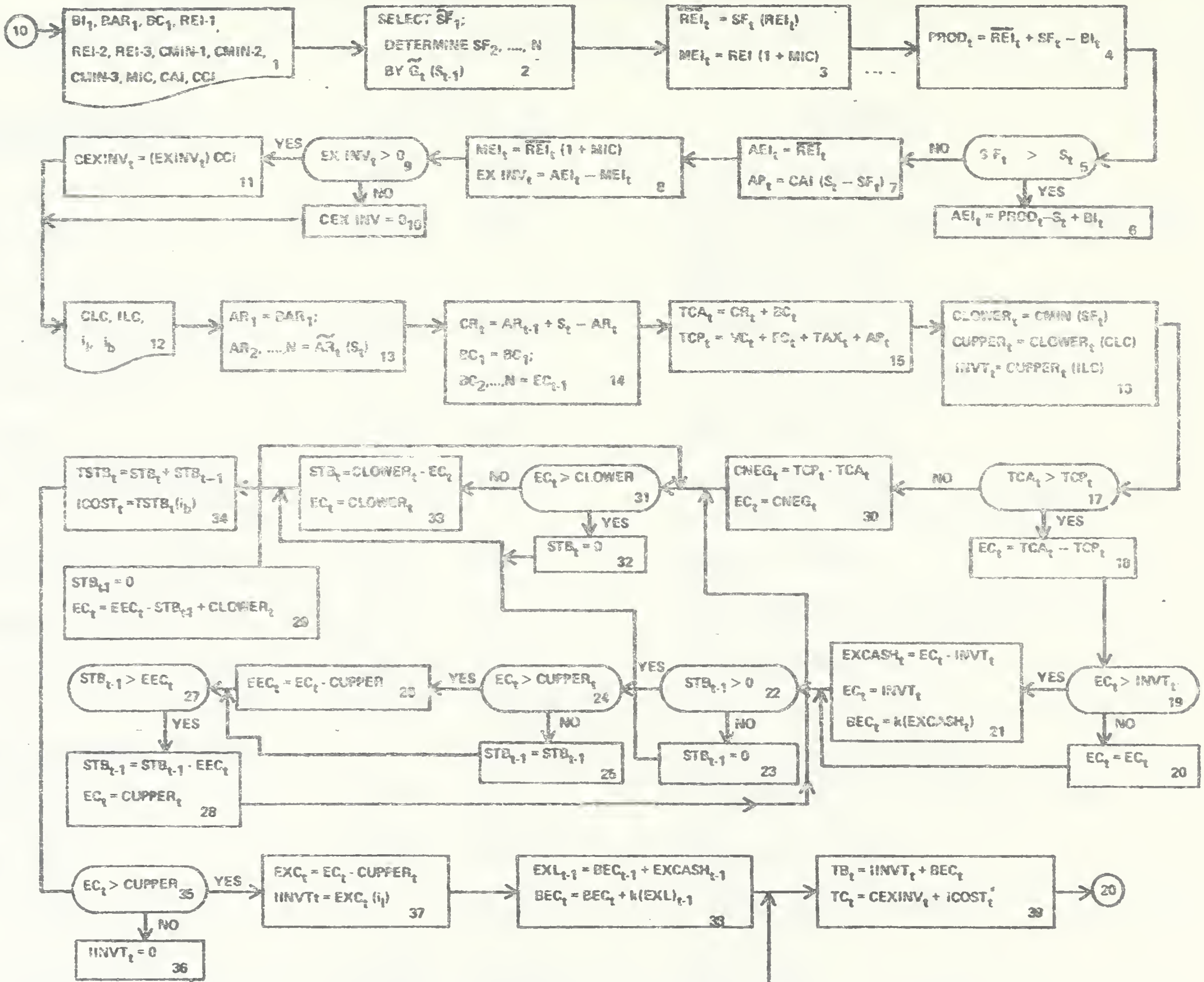


EXHIBIT 5

AN EXAMPLE OF OUTPUT GENERATED BY THE WORKING CAPITAL MODULE

(000 Omitted)

Production-Inventory System	Year 1	Year 2	COMMENTS	NUMBER OF THE PROCESSING FUNCTION IN EXHIBIT 4
Sales (S)	3800	5125.	$P_t \times Q_t$ in Exhibit 3	
Sales Forecast (SF)	4000.	4028.	$\widetilde{SF}$, is a Random Input; $SF_2 = S_1 (1 + \widetilde{G}_2)$ Where $\widetilde{G}_2 = .06$ $G_{2,\ldots,n}$ is random.	2
Required Ending Inventory ($\overline{REI}$)	400.	402.80	$SF_t(REI_t)$; REI =.1	3
Beginning Inventory (BI)	0.	600.	0 in t=1; AEI_{t-1} for $t_{2,\ldots,n}$	4
Production (PROD)	4400.	3831.	$\overline{REI}_t + SF_t - BI_t$	4
Actual Ending Inventory (AEI)	600.	402.80	If $S_t > SF_t$: = $\overline{REI}$ If $SF_t > S_t$: = $PROD_t - S_t + BI_t$	6, 7
Maximum Ending Inventory (MEI)	440.	443	$\overline{REI}_t$ (1 + MIC)	3
Excess Inventory (EX INV)	160.	0	$AEI_t - MEI_t$: = 0 if $S_t > SF_t$	8
Carrying Cost of Ex Inv (EX INV)	16.	0	(EX INV) CCI = .1	10,11

Cash-Accounts Receivable System	Year 1	Year 2	COMMENTS	NUMBER OF THE PROCESSING FUNCTION IN EXHIBIT 4
Accounts Receivable (AR)	1520.	1945.	$(S_t)\ \widetilde{AR}$; $\widetilde{AR}_1 = .4$ an $\widetilde{AR}_2 = .3795$	13
Cash Receipts (CR)	2280.	4700.	$AR_{t-1} + S_t - AR_t$	14
Beginning Cash (BC)	0.	200.	0 in t_1; EC_{t-1} for $t_{2,\ldots,n}$	14
Total Cash Available (TCA)	2280.	4900.	$CR_t + BC_t$	15

WORKING CAPITAL MODULE CONTINUED

	Year 1	Year 2	COMMENTS	NUMBER OF THE PROCESSING FUNCTION IN EXHIBIT 4
Premium for Added Investment (AP)	0.	110.	If $S_t > SF_t$: $= (S_t - SF_t)CAI$; CAI = .10027 If $SF_t > S_t$: = 0	7
Total Cash Payment (TCP)	2470.	3395.	$VC_t + FC_t + T_t + AP_t$	15
Cash Lower Bound (CLOWER)	200.	201.	$CMIN_t(SF_t)$; CMIN = .05	16
Cash Upper Bound (CUPPER)	230.	231.	CLOWER (1 + CLC); CLC = .15	16
Maximum Invested Liquidity (INVT)	252.60	259.	CUPPER (1 + ILC); ILC = .12	16
Ending Cash Balance (EC)	200	259.	If TCA_t TCP_t: $TCA - TCP_t$; $INVT_t$; or $EEC_t = STB_{t-1} + CLOWER_t$ If TCP_t TCA_t: CLOWER	17 to 29 30,31,33
New Short Term Borrowing (STB)	390	0	If TCA_t TCP_t: = 0 If TCP_t TCA_t: $TCP_t + CLOWER_t$	17,18,21 22 to 29
Payment of STB (PSTB)	0	28	If TCP_t TCA_t: = 0 If TCA_t TCP_t: An Involved Process	17 to 29
Total STB (TSTB)	390	362	$STB_t + STB_{t-1}$	34
Interest Cost (ICOST)	18.72	17.38	$(TSTB_t)\ i_b$; Tax adjusted i_b = .040	34
Excess Cash (EXC)	0	0	$EC_t - CUPPER_t = EXC_t$ $EXC_t - STB_t = EXC_t$	35,36,37
Benefit EXC (IINVT)	0	0	$(EXC_t)\ i_1$	37,39
Excess Liquidity (EX CASH)	0	1246.	If TCP_t TCA_t: = 0; If TCA_t TCP_t: $= EC_t - INVT_t$	17 to 21
Cash Benefits on EX CASH (BEC)	0	124.60	$k(EX\ CASH_t) + k\ (EX\ CASH_{t-1})$	21,38,39

The forecasted production (PROD) is also dependent on the SF. PROD equals SF plus the change in inventory during the year, i.e., \$4 million + \$.4 million = \$4.4 million. Actual ending inventory (AEI) is directly related to the difference between S and SF. Since SF > S, there was an accumulation of inventory. The AEI is determined by PROD - S + BI and AEI_1 = \$4.4 million - \$3.8 million - 0 = \$600,000. Because there was a buildup in inventory in year 1 it is necessary to determine if there was any excess inventory. Management has the choice of establishing an inventory cushion (MIC) if they are concerned about missing sales because of an inventory shortage. In exhibit 5 MIC is 5 percent, therefore, the maximum ending inventory acceptable to management is \$440,000, i.e., MEI = $\overline{REI}$ (1 + MIC) = \$400,000 (1 + .10). Thus substracting the MEI of \$440K from the actual ending inventory of \$600K there exists an excess inventory of \$160K. The cash cost of carrying excess inventory is calculated by multiplying the \$160K excess inventory times a 10 percent carrying cost. The cash cost of carrying excess inventory in year 1 was \$16K, which becomes a cost in the net present value equation.

It is assumed the AEI of \$600K is financed with zero cost accounts. Also it is assumed there is no cash outflow related to the AEI item until the next period when the CI module uses the inventory to meet the demand for the product. Thus the cost of the inventory is imbedded in the variable cost item in the CI module.

Cash-Accounts Receivable System

It is assumed the relationship between accounts receivables and sales can be represented by a frequency distribution $\widetilde{AR}$. An $\widetilde{AR}_1$ of 40 percent was randomly selected from a range of 35 to 45 percent. The actual accounts

receivable (AR) in year 1 is calculated as follows: $AR_1 = \widetilde{AR}_1(S_1) = .40(\$3.8$ million) = \$1.52 million.

The cash receipts (CR_1) are the sum of S_1 plus the change in the accounts receivable during the year, that is $AR_{t-1} - AR_t$. In year 1 CR = \$3.8 million - \$1.52 million = \$2.28 million. The total cash available (TCA) is the sum of CR_1 plus beginning cash or \$2.28 million.

If S > SF the firm pays a premium for the additional investment (AP) necessary to meet the sales demand, e.g., overtime or additional labor costs, special handling or treatment of inventory, or additional costs related to maintenance or operation of the plant and equipment. It is assumed in the model that sales are always met and there are zero lost sales. In year 1 there is no premium for additional investment because SF > S. The total cash payment is the sum of variable cost (VC), fixed cost (FC), taxes (T) and the premium for additional investment (AP). The VC, FC and T are taken from the CI module. TCP_1 was \$2.47 million. Thus in year 1 there was a negative cash flow of \$190,000, i.e., TCA of \$2.28 million - TCP of \$2.47 million.

In the WC module, management is provided substantial flexibility for controlling cash. It is assumed management establishes a minimum cash/sales forecast ratio (CMIN) and this ratio is related to the quantity of production. Minimum cash balances (CLOWER) are calculated by multiplying CMIN times SF, i.e., $CLOWER_1$ = .05 x \$4.0 million = \$200,000. In this module management has the choice of including a liquidity cushion. This liquidity cushion (CUPPER) is determined as follows: CLOWER x [1 + cash liquidity cushion (CLC)]. Thus Cupper = \$200,000 x 1.15 = \$230,000. Note the CLC can range from zero to a large whole number and depends on management discretion.

If management wishes to create an investment liquidity cushion (ILC), they add an investment layer on top of the cash liquidity cushion. The dollar investment in short term securities (INVT) equals CUPPER x (1 + ILC). The ILC can range from zero to a large whole number depending on management's judgment. In this module it is advisable to have an ILC to offset surprises in cash flow and to provide a source of funds for repaying short term borrowing (STB). In year 1 INVT = \$230,000 x 1.12 = \$257,600.

It is now possible to solve for the ending cash balance (EC). EC is dependent on the relationship between TCA and TCP. For example, because $TCP_1 > TCA_1$ the EC_1 is equal to the minimum cash level (CLOWER), \$200K.

The new short term borrowing incurred in year 1 equals TCP - TCA + CLOWER, i.e., STB_1 = \$2.47 million - \$2.28 million + \$.2 million = 390K. The STB can be viewed as the sum of the net cash outflow of \$190K plus the amount required to maintain the minimum cash balance, \$200K. There is no repayment of STB in year 1 and the total STB is \$390K. Assuming a 4.8 percent after tax interest rate, there is a cost related to short term debt (ICOST) in year 1 of \$18,700. ICOST becomes a part of the total cost of the investment and is subtracted from total annual benefits in the net present value equation.

Because $TCP_1 > TCA_1$ there is no investment in short term securities and no excess liquidity for reinvestment in the assets of the firm.

The operation of the model in year 2 provides additional insight into the impact of the WC process on total costs and benefits. In year 2 Exhibit 5 shows sales are \$5.125 million and the sales forecast is \$4.028 million. The SF_2 is an updating of the previous year's sales. A random growth value $(\tilde{G})$ of 6 percent was selected from a normal distribution that ranged from 5 to

12 percent. It is assumed management tries to estimate the growth of forecasted sales as close as possible to the actual growth in sales.

Beginning inventory in year 2 is the ending inventory in year 1 and required ending inventory is 10 percent of the sales forecast, $402,800.

Although S_2 is $5.125 million and the SF_2 is $4.028 million, the production in year 2 is only $3.831 million. The reason the production is at this level is explained by key interrelationships in the model. The inventory used in the production of S_2 is imbedded in the variable cost in the CI module. Furthermore, the dollar cost of inventory is assumed to be less than its dollar value in sales. Therefore, in Exhibit 5 the excess inventory carried forward from year 1 provided substantial cash flow to the company in year 2. Also because $S_2 > SF_2$ two other observations emerge. First, the ending inventory in year 2 was the minimum required inventory. Second, the company had to pay a premium for the costs involved in producing the goods to meet the unexpected increase in sales. This premium is $(S_2 - SF_2)$ CAI which was $1097 million x .10027 or $110,000. This premium (AP) is added to the total cash payments.

There was no excess inventory in period 2. The TCA_2 increased because of the increase in sales and the slightly lower AR value. TCA was $4.9 million and TCP was $3.395 million which provides a positive cash flow of $1.505 million.

The various levels of cash are established for year 2 as they were in year 1. Because of the $1.505 million positive cash flow, the ending cash is equal to the investment liquidity cushion of $259,000, the maximum liquidity limit. Thus, there was $1.246 million ($1.505 million - $259,000) available for investment in productive assets. It is assumed in the model that the

positive cash flow from the working capital system is invested in productive assets and earns the cost of capital, 10 percent. Thus the cash flow for the total investment receives a cash benefit of $124,600.

There is a tradeoff between investing in securities and repaying debt, which depends on the marginal difference between the two interest rates. Because the 3.6 percent after tax return on investment (i_1) is less than the 4.8 percent cost of borrowing, total short term borrowing was reduced by $28,000 the amount of the invested liquidity cushion. In this example there is no investment in securities in year 2, however, if there was no short term debt outstanding the $28,000 would be invested in securities. Finally in the examples in Exhibit 5 ending cash is at the minimum in year 1 and the maximum in year 2, however, it is possible that EC could fall in between these two limits. If this occurs, the module is designed to repay part or all of the debt and/or invest the remainder in short term securities.

The model assumes that the 10 percent return from the investment of the positive cash flow has greater utility than the repayment of a 4.8 percent loan. Also it is assumed the credit position of the company is not affected by this judgment.

APPLICATION

The output values of greatest interest to management are the profitability profiles and the mean and standard deviation statistics related to the costs and benefits from the WC and CI modules. The benefits from the two modules are: benefits associated with the plant and equipment investment in the CI module, net income + depreciation (B); the interest income from the investment in short term securities in the WC module (IINVT); the income from the investment of the excess cash generated in the WC module into productive assets (BEC). The costs are: capital costs associated with the CI module (C); cost of carrying excess inventory in the WC module (CEXINV); and the interest cost associated with the short term borrowing in the WC module (ICOST). A summary table presents the annual data for each variable. This table allows management to evaluate the separate contributions from the CI and WC modules. For example, it is possible that the cash flow from the WC module is greater than from the CI module. Also decision makers can compare the benefits from the WC module to its cost and also do the same for the CI module. Overall the summary table provides substantive insight into the interaction of all the variables in the total investment process.

The integration of the benefits and costs from the WC and CI modules is easily seen in the NPV equation. The cash flow contributions from the WC module are summarized in processing function 39 in Exhibit 4 and these benefits and costs are added to the cash flow items from the CI module. The general NPV equation for the WC-CI model is:

$$NPV = -C_0 + \frac{B_t + IINVT_t + BEC_t - C_t - CEXINV_t - ICOST_t}{(1 + k)^t}$$

A salvage value of all assets is added in the final year.

Sensitivity testing of primary variables or combinations of variables is the key to analytical insight for financial decision makers. For example, management can prepare a standard forecast using their best judgment in estimating input values for the model. After they have reviewed the profitability profiles and the summary data of the cash flow variables from each module for the standard forecast, decision makers can revise their original estimates for specific variables and examine the outcomes from a different set of policy assumptions. Management can compare the shifts in the NPV, IRR and B/C profiles under different planning assumptions and determine if there is a significant change in the profiles. Also management must assess the chances of achieving each outcome. Not only is the horizontal shift of the profile in either direction of interest, but also the change in the spread and level of the profiles. In summary, the model allows management to test various sets of WC and CI policies and examine the interrelationships between the two systems.

An example of the use of the model is provided for each of the three WC functions: inventory, accoutns receivable and cash management. In inventory management, decision makers might ask, what is the impact on the profitability profiles of a doubling in the cost of carrying inventory; or what is the affect of a 10 percent decrease in the minimum inventory level? The interrelationships between the CI and WC variables stand out in the management of accounts receivable. With the model management can specify changes in trade credit terms and then determine the size of the market share necessary to make the new trade credit policy terms profitable. Also the impact of carrying different levels of accounts receivable to existing sales is

easily tested. Cash is a residual to the financial planning process. The model provides management the data necessary to determine the appropriate tradeoff between liquidity and profitability. Additionally, because all excess cash is assumed to be invested in productive assets, there is no penalty for holding idle funds. Simulating the WC process might show there is excess cash generated through the WC module, therefore, top decision makers need to reassess if investment opportunities and management talent will in fact be available to utilize the funds generated in the WC module. A penalty function can be added to the module if investments are not available.

CONCLUSIONS

Integrating the WC and CI processes produces several interesting observations. The difference between actual sales and forecasted sales strikes at the heart of the working capital management problem. These surprise gaps between S and SF highlight the critical role of unexpected events on the WC variables and in turn the impact on the total investment process.

The isolation of the WC and CI costs and benefits provides substantive insight concerning the impact of WC flows on the costs and benefits of the total investment. The introduction of WC as a dynamic process across the entire planning horizon allows management to identify and examine the importance of WC on the future flows of the total investment.

The model assists management in evaluating investment alternatives by making it possible to test changes in various WC and CI policy decisions. The sensitivity testing of various strategic policy decisions provides insight concerning the importance of WC and CI variables on the total profitability profile. The linkage between the two financial planning systems

provides a framework for discussing the interrelationships among the various variables and hopefully will improve the planning results and reduce the negative affect of unexpected events on the profitability of the investment.

Finally, the model highlights the complexity of the total financial planning process. The long term financing process was not included, but it can be easily linked into the WC-CI model. That is, use another model to simulate the long run financial planning process and thorough analysis which alternatives allow the firm to achieve its diesired objective of long run growth in earnings per share (EPS) [9]. In selecting the investment, the objective is to determine if the IRR of the investment is greater than the rate of return required on new investment in order to achieve management's desired EPS growth objective.

The linkage of the WC module to the CI module provides additional flexibility to decision makers for analyzing the total cash flow of capital investment alternatives. Management can evaluate the simultaneous interaction of several WC variables on the investment decision. In conclusion, decision makers can use the model to simulate the total investment process and have a more complete view than previously existed when the WC variables were assumed to be implicit in the analysis.

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